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Perry Nuclear Power Plant
Docket No. 50-440
LER 2001-001-00

Ladies and Gentlemen:

Enclosed is Licensee Event Report (LER) 2001-001, Manual SCRAM Due to Decreasing Main Condenser Vacuum and Invalid Division 2 and 3 ECCS Actuations. There are no regulatory commitments contained in this letter. Any actions discussed in this document represent intended or planned actions, are described for the NRC's information, and are not regulatory commitments.

If you have questions or require additional information, please contact Mr. Gregory A. Dunn, Manager - Regulatory Affairs, at (440) 280-5305.

Very truly yours,

John K Wood

Attachment

cc: NRC Project Manager
NRC Resident Inspector
NRC Region III

IE22

NRC FORM 366 (1-2001) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 6-30-2001
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TITLE (4)
Manual SCRAM Due to Decreasing Main Condenser Vacuum and Invalid Division 2 and 3 ECCS Actuations

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 05000
4	29	2001	2001	– 001 –	00	6	14	2001	FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) (11)							
POWER LEVEL (10)			20.2201(b)		20.2203(a)(3)(ii)		50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
			20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
			20.2203(a)(1)		50.36(c)(1)(i)(A)	✔	50.73(a)(2)(iv)(A)		73.71(a)(4)
			20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)		50.73(a)(2)(v)(A)		73.71(a)(5)
			20.2203(a)(2)(ii)		50.36(c)(2)		50.73(a)(2)(v)(B)		OTHER Specify in Abstract below or in NRC Form 366A
			20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		
			20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)		50.73(a)(2)(v)(D)		
			20.2203(a)(2)(v)	✔	50.73(a)(2)(i)(B)		50.73(a)(2)(vii)		
			20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
			20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Kenneth Russell, Compliance Engineer	1-440-280-5580

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
X	JI	V	Abex	No					

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	✔ NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On 4/28/01 at 2101 hours, a main generator field ground annunciator was received due to a Stator Water System leak and actions were taken to remove the main generator from service at 2323 hours. Following generator removal/turbine trip, the main condenser vacuum degraded and was determined non-recoverable. A manual reactor scram was inserted by procedure at 0050 hours, on 4/29/01. Following insertion of the reactor scram, as a result of one turbine steam bypass valve, which stuck one half open for four minutes, invalid Division 2 Emergency Closed Cooling System (ECCS) actuation signals were received on a combination of low sensed level and high pressure signals. Then shortly after MSIV closure at 0249 hours, during the first of a series of manual SRV operations for controlling pressure, an invalid Division 3 ECCS actuation signal was received. Though the signals were invalid, all systems responded as designed to their logic actuation. Also in response to the Division 3 actuation signal, the High Pressure Core Spray System pump was over-ridden off in accordance with plant procedures. Subsequently, the A and B loops of Residual Heat Removal were required by procedure to be placed in suppression pool cooling mode of operation as a result of SRV operations. This resulted in entry into Technical Specification 3.0.3, "Limiting Condition for Operation Applicability."

The cause of the loss of vacuum was a process error that resulted in two moisture separator drain tank manways being improperly torqued during the recent refueling outage and becoming unseated when the pressure was reduced in the tank following the turbine removal from service. The cause of the reactor level/pressure actuations was determined to be localized flashing and pressurization of the sensing lines in the affected instrument reference legs.

The stator water cooling lines were repaired. The affected manways were re-worked, gaskets repaired and the remaining manways were properly retorqued; RPV level instrument reference legs were filled and vented, and operators were provided with awareness briefings and lessons learned from the event.

This event is being reported in accordance with the requirements of 10CFR50.73(a)(2)(iv), as a condition that resulted in multiple specified system actuations, and 10CFR50.73(a)(2)(i)(B), as a condition prohibited by the plant's Technical Specifications.

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

I. Introduction

On April 29, 2001, at 0050 hours, the Perry Nuclear Power Plant (PNPP), Unit 1 was manually scrammed from 16 percent rated thermal power, due to degrading main condenser [SG] vacuum while reducing power. The power reduction, performed to repair a stator cooling water system problem, resulted in the relaxation of gaskets on Moisture Separator Reheater (MSR) drain tanks and thus significant air in-leakage into the main condenser. The following system actuations occurred during the post scram transient: Reactor Protection System (RPS) [JC], Residual Heat Removal (RHR) Pumps [BO] B and C, Division 2 Diesel Generator [EK] and associated support systems including the Emergency Service Water sub-system [BI], the High Pressure Core Spray (HPCS) system [BG], Division 3 Diesel Generator [EK] and associated support systems including the Emergency Service Water (ESW) sub-system actuated. Additionally the Main Steam isolation valves [SB] closed due to low condenser vacuum. In response, Reactor Pressure Vessel (RPV) pressure was controlled by Reactor Core Isolation Cooling (RCIC) system [BN] and Safety Relief Valve (SRV) manual operations. The maximum RPV pressure was 988 psig, which was the pressure prior to the scram. During the post scram operation/transient, the minimum actual RPV water level experienced was approximately 168 inches above the top of active fuel. The RPV level was restored using the Feedwater and RCIC systems.

During the shutdown, SRVs were used to reduce RPV pressure, thus adding heat to the suppression pool. The RHR system was required to be operated intermittently in suppression pool cooling mode to control suppression pool temperature. This mode of operation requires declaring the RHR subsystems inoperable for Low Pressure Coolant Injection (LPCI) since they may not realign to the LPCI mode in the Technical Specification required time. In addition, HPCS was overridden to off in accordance with Off-Normal Instruction "Inadvertent Initiation of ECCS/RCIC (ONI-E12-1)" as a result of the second invalid low level signal. The overriden start signal was sealed in approximately 4 hours and 29 minutes until the Division 3 initiation signal was reset. This action is directed to prevent inadvertent injection of water into the RPV and results in HPCS inoperability. Technical Specification (T.S.) 3.5.1, "ECCS-Operating" requires entry into T.S. 3.0.3, "LCO Applicability" for the combination of RHR and HPCS pump inoperability.

Prior to the event, the plant was in Mode 1 at 16 percent of rated thermal power. The RPV pressure was at approximately 988 psig with reactor coolant at saturated conditions. All ECCS systems and the diesel generators were in standby and operable. Reactor Water Cleanup system was shutdown for maintenance. With RWCU system shutdown and the Reactor Recirculation [AD] pumps auto shutdown occurring during the transient, heatup and cooldown rate limits were exceeded on the associated piping (270 degree Fahrenheit per hour cooldown and 200 degree Fahrenheit per hour heatup for reactor recirculation piping; 120 degree Fahrenheit per hour cooldown and 215 degree Fahrenheit per hour heatup for RWCU piping).

An NRC notification was made via the Emergency Notification System at 0318 hours (ENF No. 37951), in accordance with the requirement of 10CFR50.72 (b)(2)(iv)(B), as an event that resulted in an actuation of the Reactor Protection System (RPS) when the reactor is critical and 10CFR50.72(b)(3)(iv), as specified system actuations, which in this case includes the RPS, HPCS, RHR B and C systems. This event is being reported in accordance with the requirements of 10CFR50.73(a)(2)(iv), a condition that resulted in multiple specified system actuations, and 10CFR50.73(a)(2)(i)(B), any condition prohibited by the plant's Technical Specifications.

II. Event Description

On April 28, 2001, at approximately 1925 hours, a plant operator performed a scheduled pump shift of the Stator Water Cooling (SWC) system [TJ]. At 2101 hours, a generator field ground alarm was received in the control room. After identification of a stator water leak on the number five generator rectifier bank, a power reduction was commenced and the generator was removed from service at 2323 hours. Following the removal of the turbine-generator from service, degradation of the main condenser vacuum was observed that required immediate operator response. At 0050 hours, on April 29, the reactor was manually scrammed and all rods were observed to insert normally. Following the scram, RPV pressure decreased to 720 psig, which was less than the pressure control setpoint of 960 psig. The pressure was controlled by normal turbine steam bypass valves operation, and subsequently decreased by the number 4 bypass valve, which stuck approximately one-half open, its position prior to the scram. The number 4 bypass valve then closed, approximately four minutes later at 0054 hours. Shortly after the bypass valve closure, a Division 2 ECCS initiation signal was received due to an invalid reactor water low level, Level 1(16.5 inches) signal. The invalid low level signal was accompanied by an invalid high RPV pressure signal. As a result of the level signal, an automatic start of the RHR B and C pumps and the Division 2 diesel generator occurred. Neither of the RHR pumps injected into the RPV since the reactor vessel pressure was above the injection valve pressure permissive and the operator subsequently placed the systems in standby. As a result of the short duration invalid high reactor pressure signal, all SRV setpoints were actuated and all SRVs opened momentarily in response. Following the initial plant transient and subsequent operator response to maintain the heat sink available

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

as long as possible, at 0215 hours, the Main Steam isolation valves (MSIV) closed due to continued degradation of the main condenser vacuum. Operators utilized manual operation of the SRVs and RCIC system to control reactor pressure and aligned the RHR system in suppression pool cooling mode to remove decay heat. The SRVs were cycled individually on multiple occasions without encountering any problems or complications in their operation.

At 0249 hours, during the first of a series of manual SRV operations, an invalid Division 3 low reactor water level, Level 2, (130 inches) ECCS initiation signal was received causing the automatic actions to occur. The actual reactor water level was approximately 230 inches, which is greater than Level 8 (219 inches). Concurrent with the Division 3 ECCS signal, an automatic Division 2 Redundant Reactivity Control System (RRCS) recirculation pump trip actuation also occurred causing loss of both reactor recirculation pumps. With no pumped flow through the recirculation loops and no flow through the RWCU system which was shutdown for maintenance, indicated temperature exceeded the cooldown rate limit for the recirculation loops and the heatup and cooldown rate limits for the RWCU piping connected to the reactor bottom head. In addition, a second momentary SRV relief signal occurred which resulted in momentary operation of all SRVs.

At 0254 hours, the operators took manual control of HPCS pump injection, in accordance with approved plant procedures, to prevent an unnecessary injection into the RPV. Additionally, no injection occurred due to the injection valve already being closed on high RPV Level 8 signal. At 0328 hours, a second train of RHR was placed in service to control suppression pool temperature as the RPV heat sink. The HPCS pump was restored to standby at 0723 hours in accordance with procedure ONI-E12-1 when the plant was stabilized. The operators maintained control over the HPCS system, which was available at all times for manual injection if required. At 1703 hours RHR A was placed in shutdown cooling mode and Mode 4, Cold Shutdown was achieved at 1930 hours.

III. Cause of Event

The Stator Water Cooling system leak was caused by procedurally applying insufficient torque to the compression fitting. Specifically, the ferrules were not adequately set on the Teflon tube, resulting in a failure to seal the tubing to ferrule interface. The compression fitting had been previously reworked during Refuel Outage 8 (RF08). A contributing cause was that the tubing was too short creating misalignment between the tubing and the compression fitting during tube assembly.

The loss of vacuum was caused by process errors that resulted from specification of insufficient torque for the manway covers on the #1 Moisture Separator Reheater (MSR) first stage(2B) drain tank and the #2 MSR second stage (6B) drain tank. The loose manway covers, internally mounted with external strongbacks, allowed air leakage into the condenser in excess of what the off-gas system could process.

The cause of the turbine steam bypass valve number 4 failure to close was determined to be a failed servo valve. The cause of the servo valve failure was indeterminate and is being further analyzed.

The cause of the invalid low level and high pressure signals was determined to be localized flashing and subsequent pressurization of the affected reference legs, resulting from the low saturation temperature/pressure relationship of the bulk fluid entering high temperature instrument lines. That is, following the pressure decrease due to the stuck open turbine steam bypass valve and during the operation of the first SRV, relatively "cold" water (low saturation temperature bulk fluid) coincident with high water level, entered the still "hot" instrument sensing lines for the RPV level and pressure reference legs. The "cold" water flashed to steam upon entry into the "hot" sensing lines creating a pressure within the reference leg side of the RPV level and pressure instruments causing momentary, approximately 70 millisecond, invalid RPV level and pressure actuation signals. Additionally, since the Rosemount 1153 transmitters used for RPV wide range level/pressure have a short time constant as compared to the RPV narrow range level transmitters, the short time constant accounts for the difference in response between the wide range and narrow range instruments. The factors that contributed to the localized flashing effect are: 1) high initial RPV water level, 2) rapid pressure decrease.

The initial investigation of the level/pressure instrument response concluded that air in the instrument lines could have been a contributor to the condition. Although air in the lines has not been completely eliminated as a cause, it is not a likely contributor since the rapidity of the transient experieneced does not reflect that of the generally much slower transients associated with air in instrument lines. However, even though air in the instrument lines is not a likely contributor, it was identified that the fill and venting practices do not appropriately prescribe filling and venting following applicable maintenance activities and should be improved.

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IV. Safety Analysis

The USAR transient that characterizes this scram event is the "Loss of Condenser Vacuum" event described in USAR Section 15.2.5. The USAR analyzed event commences at full power and normal operating pressure and results in maximum peak power of 120% power and a maximum peak dome pressure of 1,157 psig.

The 4/29 event started with the turbine off-line; the turbine having been manually tripped due to the stator water cooling leak. The power at the start of the event was 16% Rated Thermal Power (RTP) with pressure at 988 psig. Approximately 26 minutes after the turbine trip, the vacuum decreased to the point requiring the plant operators to enter Off-Normal Instruction (ONI)-N62, "Loss of Main Condenser Vacuum" procedure and started the motor feedwater pump (MFP). Approximately 10 minutes later, the RFPTs tripped on low vacuum, this was less significant than in the USAR event since the operators had already started the MFP. The control room operator then performed a manual scram. Approximately 1 hour and 25 minutes later, the MSIVs shut on low vacuum. The RCIC system was then manually started and condenser vacuum was broken. The evaluation of this event with respect to the USAR is considered bounded by the existing accident analysis.

When RHR subsytems A and B were in suppression pool cooling mode and HPCS system was overridden off, the plant was in a condition prohibited by Technical Specifications. Although both RHR A and B would have automatically realigned to inject if required, they are administratively inoperable due to the time to automatically realign being longer than allowed by Technical Specifications. In addition, HPCS was being procedurally controlled by the operators and was available to manually start and inject, if required. Since the condition occurred with the plant already shutdown, manual operation would have been directed by procedure and would be sufficient to control RPV level.

Although the two level/pressure actuations, Division 2 level 1 and Division 3 level 2, were not assumed within the USAR analysis, the plant operated as designed and no significant effects resulted (i.e., there were no equipment failures).

During the transient following the manual scram, multiple scram signals occurred, however they were determined not to be a concern relative to thermal stresses since the minimum interval between scrams was in excess of two hours and the safety function was completed during the initial manual scram.

As a consequence to the reactor recirculation pumps tripping off and the RWCU system having been isolated previously for maintenance, excessive heatup and cooldown rates were experienced in the recirculation loops and within the RWCU piping exiting the reactor vessel bottom head. The engineering review of the recirculation heatup and cooldown concluded it was bounded by previous engineering analysis, GE-NE-B13-01805-142. The RWCU heatup and cooldown are bounded by the pressure/temperature cycle analysis for scram and emergency events described in step change heatup drawings.

In summary, this event was reviewed and determined to be bounded by the USAR, other Engineering evaluations or procedural controls. Therefore this condition was determined not to be safety significant.

The Plant's staff calculated a Conditional Core Damage Probability (CCDP) value for the reactor scram with the main condenser unavailable event. The other plant conditions, Division 2 initiation, Division 3 initiation, etc. were not assumed within the analysis, since when the initiation signals occurred, the plant operated as designed. The calculated CCDP for the event was 1.8E-8. Using NRC guidance of < 1E-6 as a threshold, the event was not considered risk significant.

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V. Similar Events

No similiar events were identified for Perry.

VI. Corrective Actions

The Stator Water Cooling tubing compression fittings were disassembled and reassembled to reset each ferrule to the Teflon tube by shop controlled bench torqueing. The tubing that was deficient in length was replaced with longer tubing.

The Moisture Separator Reheater (MSR) drain tank manway covers were inspected resulting in the 2B and 6B drain tank manway gaskets being replaced. The remaining MSR drain tank manways were verified torqued to the correct value and were retorqued under hot conditions.

The failed servo valve that delayed turbine steam bypass valve number 4 from closing was replaced and the failed servo valve is undergoing further post failure inspection by an independent vendor to determine the failure mode.

Although determined not to be the cause, the RPV reference legs were filled and vented. Fill and venting practices following maintenance were detemined not to be appropriate and will be revised.

The results of the instrumentation response investigation were presented to the operating crews for increased awareness and lessons learned. The information provided included both why reference leg flashing was the cause and why some causes, such as power supply induced or instrument grounding, were eliminated. In addition, similiar simulator scenarios are being presented during the current requalification training.

Inadvertent Initiation of ECCS/RCIC (ONI-E12-1) procedure and other applicable EOP guidance will be evaluated to incorporate lessons learned or additional information and/or actions to be taken as a result of this event.

The Rosemount wide range level/pressure transmitter response times will be evaluated and a determination made for future modification appropriateness.

The above events and corrective actions have been entered in the Plants Corrective Action Program.

Energy Industry Identification System (EIIS) codes are identified in the text as [xx].